

U.S. Patent No. 4,088,172	<i>Pollach</i>	1978
U.S. Patent No. 4,545,418	<i>List et al</i>	1985
U.S. Patent No. 4,609,027	<i>Keller</i>	1986
U.S. Patent No. 5,168,914	<i>Keller</i>	1992
U.S. Patent No. 5,343,923	<i>Keller</i>	1994

The winches have wire cables, such as aircraft cable and cylindrical drums which are rotated with electric motors to wind and unwind the cables on and off the drums. The drums have uniform outer cylindrical surfaces which accommodate cables along the length of the drums. The cables during winding on the drums can crisscross around the drums. The bi-fold door opening and closing episodes occur at constant speeds determined by the speed of rotation of the drums. The wire cables require periodic adjustments and maintenance. They are subject to wear which reduces their working life. In use wire cables can have frayed cable strands which must be corrected to reduce cable breakage. Wire cables wound on steel drums produce objectionable noise.

Applicant has invented a new and novel method and apparatus for moving a bi-fold door between open and closed positions. The apparatus has door lift devices having elongated flat flexible webs having a first end connected to a shaft and a second end connected to an anchor. A reversible electric motor operating at a constant speed selectively rotates the shaft in opposite directions to wind and unwind the webs of all the lift devices on and off the shaft. The webs are wound around rotatable members in overlapping relation so that when the door is opened the rate of speed of the opening of the door increases as the diameter of the overlapping web increases. When the door is moving to the closed position the rate of speed of the closing door decreases as the diameter of the overlapped web decreases. The webs are normally aligned with rotatable members. This alignment is maintained to ensure the overlapping relation of the webs around the rotatable members. The webs do not drift or move laterally during the winding and

unwinding processes.

Figures 3 to 5 and 9 to 11 show the elongated flexible web 35 attached to a rod 83 located adjacent cylindrical member 77 so that on rotation of the cylindrical member 77 the web winds and unwinds in overlapping relation around cylindrical member 77. The overlapping relationship of the web around cylindrical member 77 is maintained by web guide plates 79 and 81 located adjacent opposite ends of the cylindrical member 77 and a closed end slot 88 in a shield 87. As seen in Figure 10, the lateral space between plates 79 and 81 is contiguous with the opposite edges of the web 35. The plates 79 and 81 confine the web to overlapping relationship during winding and unwinding from cylindrical member 77. The closed end slot 88 in shield 87 aligns web 35 with cylindrical member 77. The overlapping relationship of the web during winding and unwinding processes predicate the moving of the door at an increasing rate of speed from the closed position to the open position and moving the door at a decreasing rate of speed from the open position to the closed position. This overlapping relationship of the web on the cylindrical member is always maintained by the guiding function of the plates 79 and 81 and the closed end slot 88 in shield 87.

In use, the webs are strong, require less maintenance than prior wire cables, last longer than wire cables and substantially reduce noise when the bi-fold door is opened and closed. Applicant's webs have at least a 5 to 1 safety factor. Prior bi-fold doors do not use door lift devices having flexible webs and do not open the door at an increasing rate of speed and close the door at a decreasing rate of speed. Applicant's method of opening and closing a bi-fold door moves the panels of the door at an increasing rate of speed from a closed position to an open position and moves the panels at a decreasing rate of speed from an open position to a closed position. There is a long felt need to improve the bi-fold door opening and closing devices and overcome the disadvantages of the winches having wire cables.

Claims 1 to 6 and 18 to 20 define Applicant's method of opening a door movable between a down closed position and an up open position. The door moves at an increasing rate of speed from the closed position to the open position in response to rotation of a rotatable member which is rotated at a constant rate of speed in one direction. The door moves at a decreasing rate of speed from the open position to the closed position during rotation of the rotatable member at a constant rate of speed in a direction opposite the one direction. This is achieved by maintaining overlapping relationship of elongated webs around rotatable members during winding and unwinding of the webs about the rotatable members. Guide structures are used to prevent drifting or lateral movements of the webs during the winding and unwinding processes.

Claims 3 to 5 are dependant claims that further define the changing speeds of the door during its opening and closing. These speeds change during the entire opening and closing movements of the door.

Claim 13 defines Applicant's bi-fold door and apparatus for moving the bi-fold door between open and closed positions. The apparatus has door lift devices having elongated flat flexible webs having a first end connected to a shaft and a second end connected to an anchor. A power means selectively rotates the shaft in opposite directions to wind and unwind the webs of all the lift devices on and off rotatable members. The webs are wound in overlapping relation so that when the door is opened the rate of speed of the opening of the door increases as the diameter of the overlapping web increases. The webs are normal to the axis of rotation of the rotatable members. Each web is maintained in vertical alignment with its associated rotatable member with annular side plates on the rotatable member and a closed end slot in a shield located about the rotatable member. When the door is moving to the closed position the rate of speed of the closing of the door decreases as the diameter of the overlapping web decreases. The change in speeds of the opening and closing of the door is achieved with the rotatable members

turning a constant rate of speed. In use, the webs are strong, require less maintenance than prior wire cables and substantially reduce noise when the bi-fold door is opened and closed. Prior bi-fold doors do not use door lift devices having flexible webs as defined in Claim 13.

Claims 14, 15 and 17 depend on Claim 13. Claim 14 further defines the web as a flat plastic member. Claim 15 defines the plates secured to the shaft and the connection of the web to the plates to confine the web to its overlapping relation around the shaft during winding and unwinding of the web around the shaft. Claim 17 defines the means to adjust the working lengths of the webs so that all the webs work together to open and close the bi-fold door. These claims more particularly define parent Claim 13.

The references of record are the following U.S. patents:

U.S. Patent No. 5,168,914 Keller

U.S. Patent No. 4,949,772 Ballyns et al

U.S. Patent No. 6,042,158 Horn

U.S. Patent No. 325,986 Spangle

U.S. Patent No. 5,149,057 Meurer

Keller '914 discloses a conventional prior bi-fold door as described in the Background of the Invention and the prior art for the past 60 years. The *Keller '914* door and lift device, shown in Figure 8, comprising a motor 40, winch 46 and cable 48 wound on winch 46. Winch 46 has a cylindrical drum having a uniform diameter. Cable 48 winds and unwinds along the length of the drum. Guide structures are not used to move the cable 48 along the drum during the winding and unwinding processes. The opening and closing of the door episodes occur at a constant speed determined by the speed of rotation of the winch drum. In other words, the speed of opening of the door does not increase as the door opens. Also, the speed of closing the door does not decrease as the door closes. The total time for opening and closing the door is more than the

total time for opening and closing Applicant's bi-fold door. Applicant's shorter door opening and closing time saves power and heat energy loss from the structure equipped with Applicant's bi-fold door and lift apparatus. The cables require periodic adjustments and maintenance and are subject to wear. Applicant's web is not the mechanical equivalent to the prior art cables in lift devices for bi-fold doors.

Ballyns et al discloses a winch mechanism 16 that includes a reversible motor 40 for driving a shaft 44. A pair of spools 46 are secured to opposite ends of shaft 44. A second spool 48 is connected to shaft 44 through a clutch mechanism 46. Clutch mechanism 46 is designed to permit spool 48 to slip as required in use to accommodate differences between the rate of winding on spools 46 and play out on spool 48. Spools 46 are connected with first strap members 70 to the lower panel of a roll-up door. A second strap member connects the spool 48 to the upper edge of the uppermost door panel. The one-way clutch mechanism 54 allows spool 46 and shaft 44 to free wheel during closing of the door and spool 48 to free wheel during opening of the door. The speed of opening the door increases during the opening movement and the speed of closing the door increases during the closing movement of the door. The same spools and strap members are not used to open and close the door. *Ballyns et al* does not disclose nor suggest the use of a single rotatable member accommodating a flexible strap to both increase the speed of opening a bi-fold door and decrease the speed of closing a bi-fold door.

Horn discloses a roll-up door movable to open and closed positions with a conventional garage door opener. Door 20 is counterbalanced with a coil torsion spring 82 mounted around shaft 84. Spindles 86 secured to shaft 84 accommodate cables 90 which are connected to the bottom panel of door 20. Cables 90 are tension members used by spring 82 to counterbalance the weight of the door. The tension members are disclosed as cables. The specification states that other forms of tension members 90 may alternatively be used including, for example, cords,

ropes, belts, chains, and the like. *Col. 4, lines 46-50*. The tension members are not used to open and close the roll-up door. There is no teaching or suggestion by *Horn* of using an elongated flexible web wound on a rotatable member to increase the speed of opening a bi-fold door and being unwound from the rotatable member to decrease the speed of closing the bi-fold door.

Claim 15 depends on Claim 13. This claim further defines the means connecting the first end of the web to the rotatable means. Plates are secured to the shaft. A rigid member extends between and is mounted on the plates. The web is connected to the rigid member. This structure is not present in *Spangle*. *Spangle* discloses a belt reel rotatably mounted on a spindle C, shown as a stationary cylindrical member. Reel D is rotatably mounted on the spindle. Reel D has a hub I with outwardly directed arms. Pin or rod E mounted on opposite arms provides a connection for the free end of the belt. Reel D is turned with handle G to wind the belt on the reel. Reel D is not secured to spindle C and does not turn with spindle C. There are no plates secured to a rotatable shaft disclosed by *Spangle*. Claim 15 defines a web connection to a rotatable shaft that is not suggested by *Spangle*. The allowance of Claim 15 is requested.

Meurer shows retainer straps 66 and 67 partly around reels accommodating tapes 37 and 38 to prevent the tapes from expanding and become uncoiled. As shown in Figure 6, the opposite ends of straps 67 are secured to a base plate 76. Straps 66 and 67 do not have slots and tapes that extend through the slots. Applicant's shield with a slot from the web maintains alignment of the web as it winds and unwinds from the rotatable member. This function is not present in *Meurer*.


It is submitted that one skilled in the art of devices for opening and closing bi-fold doors would not use elongated flexible webs with rotatable members driven at a constant speed to increase the opening movement of a bi-fold door and to decrease the closing movement of the bi-fold door in view of the teachings of *Keller '914*, *Ballyns et al* or *Horn*. Winches having cables

to open and close bi-fold doors have been in use for at least 60 years. During this long period of time no one used webs as defined by the claims in bi-fold door opening and closing devices. Applicant's claimed method and apparatus satisfies a long felt need to overcome disadvantages of the winches having cables in door opening devices. Applicant's claimed method and apparatus has achieved considerable commercial success in a relatively short period of time. This success is predicated on the novel claimed method and apparatus and functions. *Ballyns et al* uses webs and drums with a clutch mechanism to increase the speed of both opening and closing movements of the door. *Horn* does not use cables or webs to control opening and closing movements of the door. In view of these facts it is submitted that Applicant's method Claims 1 to 5 and 18 to 20 and apparatus Claims 13, 14, 15 and 17 are allowable. Allowance of these claims is requested.

In view of the above remarks, Applicant requests the allowance of Claims 1 to 5, 13, 14, 15, 17 and 18 to 20.

Respectfully submitted,

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1. A method of opening and closing an opening in a structure with a bi-fold door having first and second panels, means movably mounting the first panel on the structure, hinges connecting the first panel to the second panel to allow the first and second panels to be moved from generally vertically aligned positions closing the opening to side-by-side folded positions opening the opening, and door lift devices having rotatable members having a common axis of rotation operable to selectively open and close the bi-fold door comprising: connecting the rotatable members to one panel with elongated flexible webs, aligning each web normal to the axis of rotation of a rotatable member, maintaining the alignment of the web with the rotatable member to ensure an overlapping relationship of the web around the rotatable member, simultaneously rotating the rotatable member in one direction with a power unit at a constant rate of speed to wind the webs in overlapping relation around the rotatable members to move the first and second panels at an increasing rate of speed from a closed position to an open position, and rotating the rotatable members in a direction opposite the one direction at a constant rate of speed to unwind the webs from overlapping relationship around the rotatable members to move the first and second panels at a decreasing rate of speed from an open position to a closed position.

13. A bi-fold door for an opening in a structure and apparatus for moving the bi-fold door between open and closed positions relative to the opening said door having a first panel, means for movably mounting the first panel on the structure, a second panel, means pivotally connecting the first panel to the second panel to allow the first and second panels to be moved from aligned positions closing the opening to side-by-side folded positions opening the opening, said door lift devices being operable to selectively open and close the bi-fold door, characterized by: a reversible electric motor connected to the door lift devices operable at a constant rate of speed for operating the door lift devices, said door lift devices having an elongated flat and flexible web having a first end and a second end, rotatable means attached to the first end of the web, said rotatable means including a shaft connected to the electric motor and a cylindrical means mounted on the shaft, said cylindrical means including a cylindrical member having opposite ends and annular plates located adjacent the opposite ends of the cylindrical member, said web having opposite side edges located in a contiguous relation relative to the annular plates, a cylindrical shield located around the cylindrical member and annular plates, said shield having a closed end slot aligned with the cylindrical member, said web extended through said slot whereby the annular plates and shield maintain the alignment of the web with the cylindrical member, and means connecting the first end of the web to the cylindrical means whereby upon constant speed operation of the electric motor the shaft is rotated in one direction and the web continuously winds in overlapping relation around the cylindrical member between the annular plates thereby moving the door at an increasing rate of speed from a closed position to an open position and upon reverse operation of the electric motor the shaft is rotated in a direction opposite the one direction and the web

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continuously unwinds from the cylindrical member between the annular plates whereby the door moves at a decreasing rate of speed from the open position to the closed position, means mounting the rotatable means on one of the panels, and anchor means mounted on the other panel connected to the second end of the web.

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15. The apparatus of Claim 13 wherein: the means connecting the first end of the web to the cylindrical means comprises a rigid member extended between and mounted on said plates, said first end of the web having means located between said plates accommodating the rigid member whereby when said shaft is rotated by the electric motor the web winds on itself around the cylindrical member to open the bi-fold door.

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18. A method of opening and closing an opening in a structure with a bi-fold door having hinged panels, means movably mounting the door on the structure for movement between a down closed position to an up open position, and a door lift device having a rotatable member driven with a reversible electric motor to selectively move the door between the closed and open positions thereof comprising: connecting the rotatable member to one panel of the bi-fold door with an elongated flexible web, guiding the web with laterally spaced annular plates located adjacent the opposite ends of the rotatable member and a web accommodating slot in a shield located around the rotatable member to maintain an overlapping relationship of the web around the rotatable member, rotating the rotatable member in one direction at a constant rate of speed to wind the web in overlapping relation around the rotatable member to move the door at an increasing rate of speed from the closed position to the open position, and rotating the rotatable member in a direction opposite the one direction at a constant rate of speed to unwind the web from overlapping relationship around the rotatable member to move the door at a decreasing rate of speed from the open position to the closed position.

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19. The method of Claim 18 including: operating the reversible electric motor
at a constant rate of speed to rotate the rotatable member at a constant rate of speed.
